

Space Weather Forecast

Issued on Sunday, 17 December 2023 at 00:44 Local

This forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Minor/Moderate Geomagnetic Storm (G1/G2) likely in current UTC day in a generally disturbed four-day forecast period. Risk of further Moderate Radio Blackouts (R2) and minor solar radiation storms (S1) now moderating slightly.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity reverted to low over the past 24 hours, with X-ray activity showing only Common-class flares, peaking with a long-period upper-end event from the recent most active sunspot group at 16/1434UTC.

There were eight sunspot regions on the facing side of the Sun at the end of the UTC day of Saturday 16 December, however this number was slightly volatile over the period as a whole given a number of new magnetically unipolar regions, mainly in the eastern solar hemisphere. The most notable activity in the current cohort was again from the large and complex sunspot responsible for recent Moderate and Strong X-ray flares, although this group became difficult to fully discern near the southwestern solar horizon. Also of note were a sunspot group to its immediate northeast, which saw a new trailing spot emerge in the period, and also one near the middle of the Sun which underwent minor spot proliferation as it approached the solar meridian.

As mentioned in previous issues of this guidance, a 'filament eruption' that occurred shortly prior to the start of this past 24-hour window at 15/2100UTC has now potentially been accounted for as a very faint Coronal Mass Ejection (CME) seen heading south in satellite imagery. Modelling suggests arrival of this CME early in the UTC day of Wednesday 20 December as most probable.

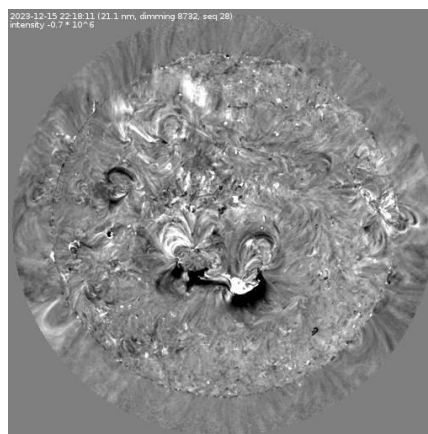


Figure 0: SIDC ROB-processed extreme UV time-integrated image of the 15/2100UTC south central 'filament eruption'. This feature has tentatively been associated with a weak CME heading mainly south of the Sun-Earth line, but with a provisional glance of Earth possible early in the UTC day of Wednesday 20 December.

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Other activity noted in the period included a 'prominence eruption' from the southeast at 16/1100UTC, and a CME tied to the peak flare of the 24 hours at 16/1434UTC. The former plays no part in the forecast, and the latter is awaiting analysis but similar is assumed given its far westward emission location.

Solar Wind / Geomagnetic Activity: Solar winds were initially reflective of waning effects from a weak CME arrival at 15/1057UTC. This had possibly ceased by the UTC evening, with a stable, slightly elevated trace then taking over.

The solar wind speed fell from elevated to slightly elevated levels in the 24 hours. The number of particles in the solar wind was slightly elevated but steady over the same timeframe. The magnetic field associated with these particles was somewhat erratic in character, with an early peak in slightly elevated levels later moderating, while the north-south component was generally unremarkable.

The net result of the above solar wind measures was for peak geomagnetic activity a little below Minor Geomagnetic Storm G1, with the 00-03UTC interval coming nearest while the CME's effects were strongest.

Energetic Particles / Solar Radiation: Proton flux fell from an early peak of 13pfu at 16/0015UTC, (i.e. Minor Solar Radiation Storm S1, which starts at 10pfu) with this having been in response to the recent larger flares from the complex sunspot. It has since dropped near resting background below 1pfu, with higher energies of protons unmoved throughout.

Four-Day Space Weather Forecast Summary

Solar Activity: There remains a chance of further Moderate activity and a slight chance of Strong, both largely tied to the fortunes of the largest sunspot group, which is due to rotate off the facing side into the new UTC working week. While some further active regions are likely over the eastern solar horizon, these are unlikely to fully compensate, and there is a step-wise moderating risk of significant flares as a result.

Solar Wind / Geomagnetic Activity: There are up to three CMEs that now feature in the forecast. The Strong-class X-ray flare from 14 December produced a moderately fast CME which is likely to have an Earth-directed component due within the next 24 hours, i.e. the UTC day of Sunday 17 December. This is thought likely to have swept up an earlier CME from the northwest of the Sun - also from 14 December. Finally, there is further weak influence from the 15/2100UTC south-central filament eruption due in the UTC morning of 20 December.

The 'coronal hole'-driven forecast is simpler, with a fast wind due on day three, Tuesday 19 December.

Initially quiet geomagnetic activity is likely to give way to Minor or Moderate (G1/G2) geomagnetic storms inside the first 24 hours with the combined arrival of the 14 December CMEs. Activity should then wane for a time into the new working week, ahead of a fast wind, which may reach elevated levels. Rounding out the forecast is then a weaker 15 December filament CME early in the UTC day of 20 December.

Energetic Particles / Solar Radiation: High energy proton flux remains slightly elevated, and as such the chances of further Minor Solar Radiation Storm (S1) conditions are above raw values for the constituent sunspot regions on the Sun, rated a daily chance over the remainder of the current UTC weekend should the large sunspot group flare appropriately again, and
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waning from here as the sunspot group rotates onto the far side. Forecast CME arrivals during this time may also help to increase proton levels.

Geomagnetic Storms:

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	70	20	30	20
Strong	G3	No	20	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Radio Blackouts - X Ray Flares:

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	45	40	40
Very Active	R3 to R5 X	No	15	10	1	1

Solar Radiation Storms - (High Energy Protons):

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	Yes	30	15	10	10
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)